PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04B 7/06	A1	(11) International Publication Number: WO 00/51264 (43) International Publication Date: 31 August 2000 (31.08.00)

(21) International Application Number: PCT/EP99/01304

(22) International Filing Date: 24 February 1999 (24.02.99)

(71) Applicant (*for all designated States except US*): NOKIA NETWORKS OY [FI/FI]; P.O. Box 300, FIN-00045 Nokia Group (FI).

(72) Inventor; and
(75) Inventor/Applicant (*for US only*): PIIRAINEN, Olli [FI/FI]; c/o Nokia Telecommunications Radio Access Systems, P.O. Box 319, FIN-90651 Oulu (FI).

(74) Agents: PELLMANN, Hans-Bernd et al.; Tiedtke-Bühling-Kinne et al., Bavariaring 4, D-80336 München (DE).

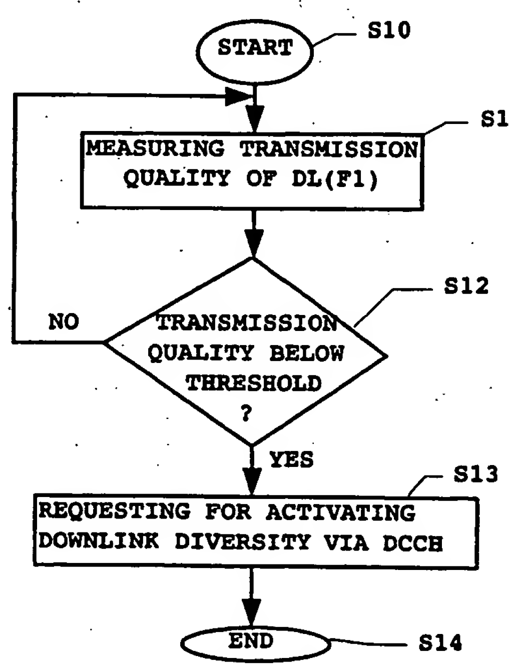
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: A METHOD FOR IMPLEMENTING DOWNLINK DIVERSITY IN A RADIO TELECOMMUNICATION SYSTEM OPERATED ACCORDING TO TDMA

(57) Abstract

The present invention proposes a method for implementing downlink diversity in a radio telecommunication system operated according to time divisional multiple access TDMA and consisting of at least one radio transceiver device (BS) and at least one terminal device (MS), the method comprising the steps of transmitting data from said at least one radio transceiver device (BS) to a respective one of said at least one terminal devices (MS) using a first downlink channel (DL(F1)), and transmitting the same data from said at least one radio transceiver device (BS) to said respective one of said at least one terminal devices (MS) using a second downlink channel (DL(F2)), upon request of said respective terminal device (MS). Thereby, the capacities for connection provided by the air interface can be used to improve connection quality without the need to add hardware resources at the terminal device side or radio transceiver device side.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

A METHOD FOR IMPLEMENTING DOWNLINK DIVERSITY IN A RADIO TELECOMMUNICATION SYSTEM OPERATED ACCORDING TO TDMA

FIELD OF THE INVENTION

The present invention relates to a method for implementing downlink diversity in a radio telecommunication system operated according to time divisional multiple access (TDMA) and consisting of at least one radio transceiver device and at least one terminal device.

BACKGROUND OF THE INVENTION

Mobile telecommunication systems (also called cellular systems) have widely spread in recent years and are quite beneficial for a subscriber to the mobile telecommunication system in that using his terminal device or mobile station MS, he can communicate with nearly any desired other subscriber in his or other mobile telecommunication systems or the public switched telephone network PSTN.

Generally, such mobile telecommunication systems consist of at least one terminal device MS which communicates with one of at least one radio transceiver devices or base stations BS constituting the telecommunication network. The plurality of base stations BS are controlled by a base station controller device BSC in combination with a mobile switching service center MSC. The latter one may also provide an interface to the PSTN network.

With the increasing traffic handled by such networks interference problems between a plurality of ongoing connections arise, which decrease transmission quality. Moreover, dependent on the location of use of a terminal device (for example in hilly terrain or in a typical urban

area), fading problems due to multi-path propagation caused by reflection and/or shadowing by buildings/mountains may arise, which also contribute to a decrease in transmission quality.

Transmission quality is thus adversely affected in uplink UL (from a respective terminal device MS to a respective radio transceiver device BS) as well as in downlink DL direction (from a respective radio transceiver device BS to a respective terminal device MS).

In order to alleviate such problems, it is known to implement different diversity methods and better receiver devices for uplink transmission in mobile telecommunication systems in order to improve the system performance in uplink direction.

However, since such measures are easier to implement in connection with radio transceiver devices BS than terminal devices, there remains a problem in that the signal quality in downlink mostly limits the performance of the telecommunication system.

However, when implementing diversity methods at the terminal device side, this will require the provision of two or more antennas and two or more receivers. Additionally, the respective antennas would have to be spaced apart from each other in order to decrease the correlation between antennas.

Such a solution, on one hand increases the dimensions of a terminal device due to spaced plural antennas to be provided, and also increases the required hardware due to the plural antennas as well as plural receivers. This, in turn, will lead to increased costs of the terminal device.

In addition, such an expenditure of hardware resources is not required in all situations, rather it is required only in case of poor or adverse channel conditions. Thus, the additional hardware resources provided for to establish space diversity at the terminal device side would be useless in most times.

Also, instead of locating the diversity at the terminal device side, it could be implemented at the radio transceiver device side. This could be done by providing several antennas at the respective radio transceiver devices BS and to transmit the signals separately in time and phase in order to provide downlink diversity.

However, similarly as explained above, the expenditure in hardware resources at the network side would be unused in most times. Therefore, substantially the same drawbacks as mentioned above are attributable to this solution.

SUMMARY OF THE INVENTION

Hence, it is an object of the present invention to provide a method for implementing downlink diversity in a radio telecommunication system operated according to time divisional multiple access (TDMA) and consisting of at least one radio transceiver device and at least one terminal device, which is free from the above drawbacks and which does not require any additional hardware resources.

According to the present invention, this object is achieved by a method for implementing downlink diversity in a radio telecommunication system operated according to time divisional multiple access TDMA and consisting of at least one radio transceiver device and at least one terminal device, the method comprising the steps of transmitting

data from said at least one radio transceiver device to a respective one of said at least one terminal devices using a first downlink channel, and transmitting the same data from said at least one radio transceiver device to said respective one of said at least one terminal devices using a second downlink channel, upon request of said respective terminal device.

Advantageous further developments of the present invention are as set out in the dependent claims.

Additionally, the present invention also proposes accordingly adapted terminal devices and radio transceiver devices.

Accordingly, the proposed method provides an advantage in that a similar diversity gain (as known from uplink) can be obtained in downlink without any additional hardware being required. For example, measurements of the inventor have shown that a diversity gain of about 5 dB can be obtained for a channel established in a typical urban area (TU channel).

Additionally, an interference diversity gain can be obtained. Stated in other words, interference can be reduced, as the interference is also averaged due to the additional channel being activated, thereby providing diversity in frequency and, also possible, in time.

Moreover, the proposed method is adaptive and activates diversity only upon request of a respective terminal device dependent on the condition of the air interface (like transmission quality and available transmission capacity). This results in an effective use of the transmission capacities via the air interface in order to improve the

connection quality without adding any additional hardware resources neither to a terminal device MS nor to a radio transceiver device BS.

In general, the method provides more flexibility for TDMA systems in order to make maximum use of the air interface.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more readily understood when referring to the accompanying drawings, in which

Fig. 1 shows schematically a part of a radio telecommunication network with downlink diversity being implemented between a radio transceiver device BS and a terminal device MS;

Fig. 2A illustrates a flowchart of the method steps as performed on the terminal device MS side;

Fig. 2B illustrates a flowchart of the method steps as performed on the radio transceiver device BS side; and

Fig. 3 schematically shows details concerning first and second active downlink channels on a TDMA frame level.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will subsequently be described in detail with reference to the drawings.

According to the present invention, downlink diversity is realized by using frequency and/or time separation. This means, that at least two different channels (frequencies and/or time slots) are activated for transmitting the same

data contained in a respective burst during a time slot of a TDMA frame to the terminal device or mobile station MS, respectively. Moreover, since downlink diversity is activated upon request, the requesting mobile station MS knows that a second channel (frequency and/or time slot) will be / is activated and waits for the second transmission of the same data, also received via a first channel.

Having received the same data transmitted via the at least two channels, the terminal station MS combines the data contained in the separately transmitted bursts in an equalizer means using either pre- or post-combining methods. This means that signal combining operations can be effected before supply of the signals to an equalizer or after being processed by an equalizer.

In case of pre-combining, only one equalizer is required as the signals are combined before being supplied to the equalizer. That is, when a plurality of two or more (diversified) bursts are successively received, the first one can be stored in a buffer memory while waiting for the reception of the other burst(s). After the subsequent (second) burst has been received, some pre-combining methods could be used for signal combination. Thus, there is only a need for one equalizer.

In case of post-combining, however, (at least) two equalizers are required, dependent on the amount of diversity established. Namely, if a burst is transmitted twice using an implemented diversity feature, two equalizers will be used, while in case the burst is transmitted three times, three equalizers could be used.

This is similar to the processing applied by radio transceiver devices BS in uplink diversity methods, so that according to the present invention, also the same kind of diversity gain as in the uplink case is achieved.

As regards the above mentioned pre-combining methods, these include the following methods used for signal combination in case of diversity:

1) Maximum-Ratio-Combining, according to which the signals to be combined are weighted in terms of their signal quality before being combined;

2) Equal-Gain-Combining, according to which the signals to be combined are equally weighted (irrespective of their signal quality) before being combined; and

3) Selection combining, according to which the signals to be combined are not combined, but the signal with the better quality is selected.

Basically, there are two different implementations in connection with the proposed method:

On one hand, using the (at least) second channel (2^{nd} frequency) in downlink, the transmission of the same data as transmitted via the first (reference) channel (1^{st} frequency) is effected at a different frequency at the same time ("pure frequency diversity"). This means that the same time slot TS of a TDMA frame is used on the second channel as on the first channel. Although no additional antenna means are required in this case for the terminal device MS, a second receiving means for the terminal devices is needed, thereby to a certain extent increasing costs.

On the other hand, using the second channel in downlink, transmission of the same data as transmitted via the first channel is effected at a different or the same frequency

but at a different time (i.e. during a different time slot TS of a respective TDMA frame). This leads to "pure time diversity if the same frequency is used and to a mixed frequency/time diversity feature if a different frequency is used.

In the above cases, the data are separately transmitted as regards the used channel (defined by the used frequency as well as the used time slot). The data (or samples) contained in the bursts received first can be stored or buffered in the equalizer at the reception side and equalization is performed after the second burst containing the same data is received. Equalization can be performed after having used any of the above mentioned combining methods. Consequently, the same receiver can receive both bursts as the different data bursts are at least separated in time and possibly also in frequency, so that in this case no additional hardware is required for a respective terminal device to carry out the proposed method.

Only little more digital signal processing (DSP) power is required, but as the digital signal processing power is continuously increasing and terminal devices are adapted to process several time slots of a single frame, this is not a critical point to the present invention.

The time difference between the first and second data burst transmission (when assuming that diversity uses only one additional channel, i.e. an (additional) second channel) on the first and second channel can be expressed in numbers of time slots. For example, the second transmission using the second channel can take place at a fixed time slot before the first (reference) transmission using the first channel. In this connection it is conceivable to arrange a difference of one time slot or four time slots, for

example. Alternatively, the time slot to be used for the second channel could be configured upon activation of the second channel. The use of a respective time slot for the (diversified) transmission is dependent on the availability of a "free", i.e. unused time slot, which are not occupied by other mobile stations. Also, the timing between received and transmitted time slots could be taken into account so that this does not occur at the same time, because the transmitter (of a terminal station) can disturb the receiver (of the terminal station) if transmission and reception occurs simultaneously.

The receiver at the terminal device used when diversity (two or more signal "branches", i.e. channels) according to the present invention is established is basically the same kind of receiver as for a single signal branch (i.e. when no diversity is established). Therefore, additional processing power is not significant. Moreover, since nowadays terminal devices are adapted to process several time slots of a respective frame, they provide enough processing power for the proposed method. Additionally, since the combining of the two signal branches is effected in the equalizer, the channel decoding processing has to be executed only once as normally and no extra signal processing is required in this connection.

The above outlined general functionality of the present invention will now be set out in greater detail.

Fig. 1 of the drawings shows schematically a part of a radio telecommunication network with downlink diversity being implemented on the air interface between a radio transceiver device BS, denoted by 1 and being provided with an antenna means 1A, and a terminal device MS, denoted by 2 and being provided with an antenna means 2A. In an initial

stage (not shown) a transmission and/or communication is active between the terminal device MS 2 and the radio transceiver device BS 1 in uplink UL direction as well as in downlink direction DL, with the transmission in downlink DL being based on a first (single) downlink channel DL(F1) based on a first frequency F1. In case downlink diversity is required by the terminal device MS 2, a corresponding request is forwarded from the terminal device MS 2 via for example a (logical) control channel CCH in uplink UL direction to the radio transceiver device BS 1. In response thereto and if available, the radio transceiver device BS 1 will allocate and/or activate a second downlink channel DL(F2) for downlink transmission between the radio transceiver device BS 1 and the terminal device MS 2, with the transmission in downlink using said second channel being based on a second frequency F2. (However, as mentioned above, a second frequency is not necessarily required for the second channel, but the second channel can be established using a different time slot activated while still using the same frequency F1 as for the first channel). Then, both downlink channels DL(F1) and DL(F2) (frequencies and/or time slots) are simultaneously active for transmitting the same data bursts thereon, thereby providing downlink diversity. The conditions for issuing the request and allocating said second channel will be described further below.

Fig. 2A illustrates a flowchart of the method steps as performed on the terminal device MS side, with the assumption that a downlink transmission using a first downlink channel DL(F1) based on said first frequency F1 is already active.

Then, the flow starts in a step S10.

In a subsequent step S11, the terminal device MS measures the transmission quality of the (for the concerned terminal device at present single) active downlink channel DL(F1) at the frequency F1 (and a time slot within a TDMA frame).

Thereafter, it is checked in a step S12 whether the measured transmission quality is below a transmission quality threshold level.

The transmission quality may be defined as a received signal strength or as a bit error rate of the received signal, or the like. Also, the threshold level may be a suitable one which is predetermined for all terminal devices. Alternatively, the threshold level may be informed to the terminal device by the radio transceiver device BS dependent on a monitored location of the terminal device (e.g. in a hilly terrain or in a typical urban area), so that the threshold level may be set dependent on the environmental conditions.

If, in step S12, the transmission quality is not below said threshold level (NO in step S12), the flow returns to step S11. However, if the transmission quality is below said threshold level (YES in step S12) the method flow advances to a step S13.

In step S13, the terminal device MS issues a request to the base station BS for downlink diversity to be activated. Such a request can be forwarded from the terminal station MS to the base station BS via a (logical) uplink control channel such as a dedicated control channel DCCH.

In a following step S14, the processing as effected by the terminal station MS ends.

Now with reference to Fig. 2B, a flowchart of the method steps as performed on the radio transceiver device BS side is illustrated.

The method starts in a step S20.

In a following step S21, the radio transceiver device BS monitors the uplink dedicated control channel DCCH.

Then, in a subsequent step S22, it is checked whether via said dedicated control channel DCCH a request for an additional channel is received from a respective terminal device MS. If no such request is received (NO in step S22), the process returns to step S21 and monitoring the dedicated control channel is continued. If, however, such a request is received at the radio transceiver device from a requesting terminal device (YES in step S22), the method proceeds to step S23.

In step S23, it is then checked, whether there is transmission capacity available on the air interface of the respective radio transceiver device BS serving a corresponding cell of the radio telecommunication system. Transmission capacity here means for example at least one available frequency at the radio transceiver device. Also, transmission capacity here could mean an available time slot in a TDMA frame transmitted on the carrier frequency of the first (downlink) transmission.

If no further transmission capacity is available (NO in step S23), the flow advances to step S24. In step S24, an other action is initiated. This means that for example a handover is initiated due to the previously measured (S11, S12) insufficient transmission quality, or that the ongoing transmission via the active channel DL(F1) is just dropped.

After step S24, the flow proceeds to step S27 and the method as performed by the radio transceiver device BS ends.

However, if further transmission capacity is available (YES in step S23), the flow advances to step S25. In step S25, the radio transceiver device BS activates an additional channel DL(F2) from the radio transceiver device BS. The additional channel is characterized by the frequency of and/or time slot used in the transmitted TDMA frame, which parameters are set when activating the additional channel.

Namely, in a specific example, in response to the receipt of said request for an additional channel, the radio transceiver device BS activates a requested additional channel at a second frequency DL(F2) and sets a time slot in a TDMA frame of said second channel DL(F2) to be used for transmission of the same data as transmitted on the first channel DL(F1).

Then, upon the parameters of the additional channel being set in step S25, the terminal station MS, in a following step S26, is informed about these parameters (i.e. frequency and/or time slot defining the channel). Thereby, the terminal device is informed on which channel, i.e. on which frequency and/or at which time (time slot) the redundant data, i.e. the same data as the data transmitted via the first channel, can be received. Also, at this time, the transmission capacity information are updated in that an additional channel (frequency and time slot) has been assigned

Then, in the following step S27, the method ends as regards the radio transceiver device BS.

Fig. 3 schematically shows details concerning first and second active downlink channels on a TDMA frame level.

As an example only, a TDMA frame according to GSM specification has been chosen which comprises eight time slots TS0, ..., TS7 per frame. However, according the American IS-54 system specification, TDMA frames having six time slots only are defined. Apparently, the present invention is also applicable without any problem to systems which have a number of time slots per TDMA frame which is different from eight, and not limited to an implementation to any of the above named specifications.

Fig. 3 a) shows an example of the downlink channel DL(F1) at a first frequency F1. The data DATA are transmitted as a burst in time slot TS5, for example. This initially active connection is defined as a reference for the subsequent explanations.

Fig. 3 b) shows an example in which the second, additionally activated channel DL(F2) at a second frequency F2 is used to establish downlink diversity. In this example, the same data DATA as the data transmitted on the first channel are transmitted at a different frequency (here F2), but at the same time, i.e. during the same time slot as on the first channel (TS5 in the chosen example). In this case, the implemented diversity is a "pure" frequency diversity.

Furthermore, Fig. 3 c) illustrates an example according to which the diversity is achieved by using a different frequency F2 for the second channel DL(F2) (as compared to the first channel DL(F1)) and also by using a different time. Stated in other words, as shown in Fig. 3 c), on the second channel DL(F2), the same data DATA as those

transmitted on the first channel are transmitted at a different time, i.e. during a different time slot (TS1 in the chosen example). This different time slot may be predetermined and fixed and differs from the time slot of the reference transmission (Fig. 3 a)) by an integer number of time slots. The time slot used on the second channel may precede or follow the time slot used on the first channel (frequency) defined as a reference.

Finally, Fig. 3 d) shows a case in which the time slot TS to be used for the additional channel DL(F2) is configured. For example, a time slot TS1, TS2, or TS4 for example may be used for transmitting the same data DATA (in Fig. 3d) denoted by "(D)"), if time slot TS5 is used as a reference on the first channel. Such a modification is advantageous in case a frequency like for example F2 is reserved for establishing downlink diversity. Then, the time slots TS available on said frequency are allocated to different diversity requesting terminal devices. However, a time slot to be assigned for implementing diversity would have to be available on said frequency. The criteria for selecting a respective time slot have been specified herein above, so that a repeated explanation thereof is considered to be dispensable.

Note that in case of the situation as depicted in Figs. 3c) and d), the implemented diversity is a "mixed" frequency and time diversity.

Nevertheless, as mentioned earlier above, the present invention may also be implemented also as a "pure" time diversity. Then, not shown in the drawings, Figs. 3c) and d) could be modified such that the second channel is active on the same transmission frequency (i.e. F1) as the reference transmission illustrated in Fig. 3a), with the

difference in channels in downlink transmission direction being manifest due to the different used time slots TS.

As has been described in the foregoing, the present invention proposes a method for implementing downlink diversity in a radio telecommunication system operated according to time divisional multiple access TDMA and consisting of at least one radio transceiver device BS and at least one terminal device MS, the method comprising the steps of transmitting data from said at least one radio transceiver device BS to a respective one of said at least one terminal devices MS using a first downlink channel, and transmitting the same data from said at least one radio transceiver device BS to said respective one of said at least one terminal devices MS using a second downlink channel, upon request of said respective terminal device MS. Thereby, the capacities for connection provided by the air interface can be used to improve connection quality without the need to add hardware resources at the terminal device side or radio transceiver device side.

It should be understood that the above description and accompanying figures are merely intended to illustrate the present invention by way of example only. The preferred embodiments of the present invention may thus vary within the scope of the attached claims.

CLAIMS

1. A method for implementing downlink diversity in a radio telecommunication system operated according to time divisional multiple access TDMA and consisting of at least one radio transceiver device (BS) and at least one terminal device (MS), the method comprising the steps of:

transmitting data (DATA) from said at least one radio transceiver device (BS) to a respective one of said at least one terminal devices (MS) using a first downlink channel (DL(F1)), and

transmitting the same data (DATA) from said at least one radio transceiver device (BS) to said respective one of said at least one terminal devices (MS) using a second downlink channel (DL(F2)), upon request (S13) of said respective terminal device (MS).

2. A method according to claim 1, further comprising the steps of

measuring (S11) the transmission quality of said first downlink channel (DL(F1)) to said terminal device (MS), and

checking (S12), whether the measured transmission quality is below a transmission quality threshold value,

wherein a request (S13) for activating said second downlink channel (DL(F2)) is issued, if the measured transmission quality is below said transmission quality threshold value.

3. A method according to claim 1, further comprising the steps of

determining (S23), whether transmission capacity is available or not, and

activating (S25) said second downlink channel (DL(F2)), if transmission capacity is available.

4. A method according to claim 1, wherein said second downlink channel (DL(F2)) uses a different frequency than said first downlink channel (DL(F1)).

5. A method according to claim 4, wherein said same data are transmitted, using the different frequencies (DL(F1), DL(F2)), at the same time (TS5).

6. A method according to claim 4, wherein said same data are transmitted, using the different frequencies, at different times.

7. A method according to claim 1, wherein said second downlink channel uses the same frequency than said first downlink channel (DL(F1)).

8. A method according to claim 7, wherein said same data are transmitted, using the same frequency, at different times.

9. A method according to claim 6 or 8, wherein said different times differ in an integer number of time slots (TS) of a TDMA frame.

10. A method according to claim 9, wherein said integer number is fixed and predetermined.

11. A method according to claim 9, wherein said integer number is determined upon activation of said second downlink channel.

12. A terminal station adapted to implement the method according to any of the above claim 1 to 11.

13. A radio transceiver device adapted to implement the method according to any of the above claim 1 to 11.

FIG. 1

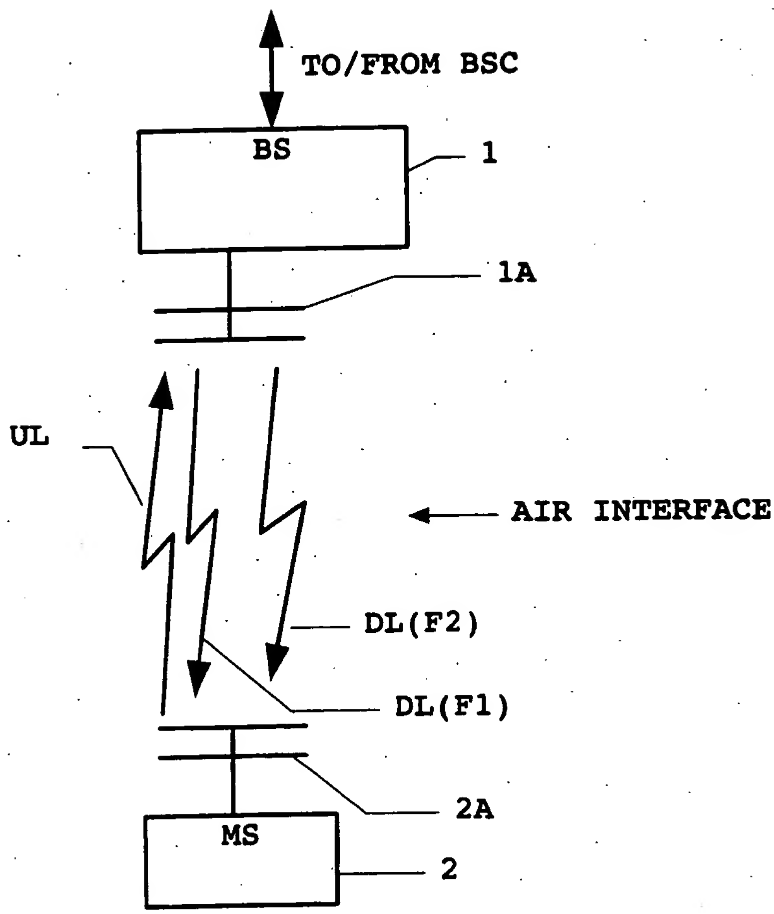


FIG. 2A

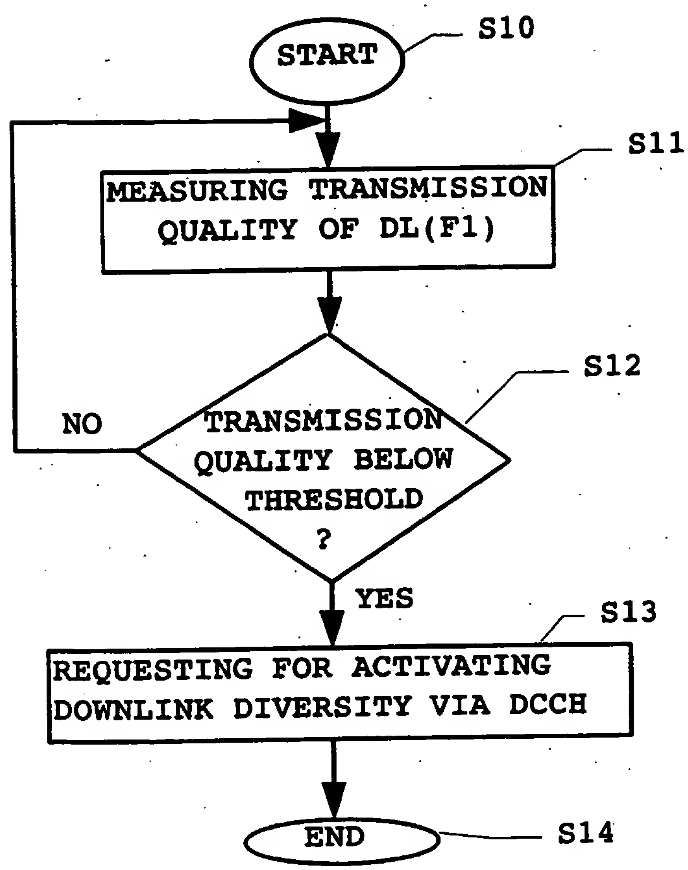

START
S10
S11
MEASURING TRANSMISSION QUALITY OF DL(F1)
S12
NO
TRANSMISSION QUALITY BELOW THRESHOLD ?
YES
S13
REQUESTING FOR ACTIVATING DOWNLINK DIVERSITY VIA DCCH
END
S14

FIG. 2B

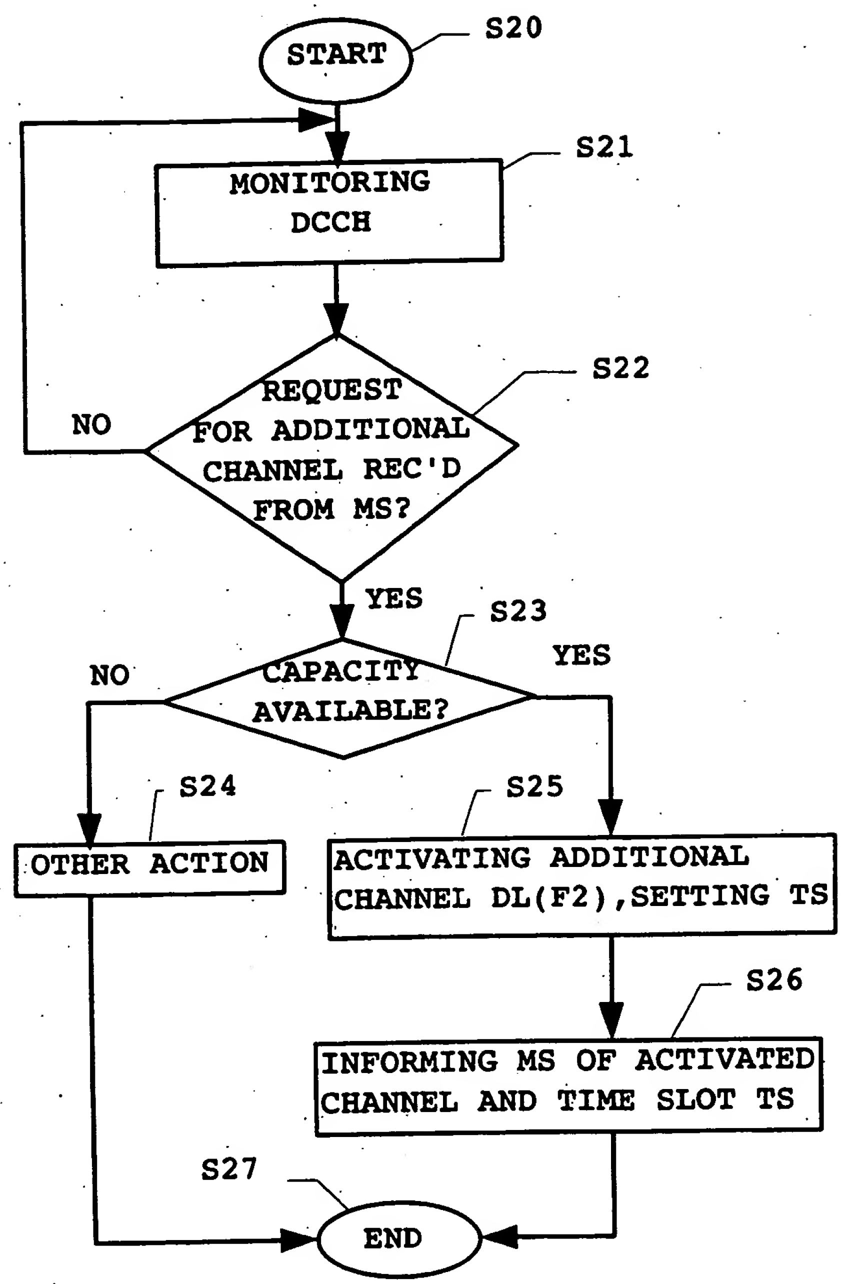

START
S20
MONITORING DCCH
S21
REQUEST FOR ADDITIONAL CHANNEL REC'D FROM MS?
S22
NO
YES
CAPACITY AVAILABLE?
S23
NO
YES
OTHER ACTION
S24
ACTIVATING ADDITIONAL CHANNEL DL(F2),SETTING TS
S25
INFORMING MS OF ACTIVATED CHANNEL AND TIME SLOT TS
S26
S27
END

FIG. 3

a)

TS0	TS1	TS2	TS3	TS4	TS5	TS6	TS7
					DATA		

DL(F1)

1 TDMA frame = 8 time slots TS0 ...TS7

(DL(F1) at frequency F1, (reference))

b)

TS0	TS1	TS2	TS3	TS4	TS5	TS6	TS7
					DATA		

DL(F2)

(DL(F2) at frequency F2),"at the same time"

c)

TS0	TS1	TS2	TS3	TS4	TS5	TS6	TS7
	DATA						

DL(F2)

(DL(F2) at frequency F2),
"at a fixed time (e.g. 4 time slots TS)
before reference transmission"

d)

TS0	TS1	TS2	TS3	TS4	TS5	TS6	TS7
	(D)	(D)		(D)			

DL(F2)

(DL(F2) at frequency F2),
time slot TS for additional channel to be
configured

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 99/01304

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 345 600 A (DAVIDSON ALLEN L) 6 September 1994 (1994-09-06) column 2, line 29 -column 5, line 48; figures 1-3	1-13
X	EP 0 735 701 A (AT & T CORP) 2 October 1996 (1996-10-02) abstract; claim 1	1,12,13
A	US 5 657 325 A (LOU HUI LING ET AL) 12 August 1997 (1997-08-12) abstract	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 November 1999	14/12/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Burghardt, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 99/01304

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5345600 A	06-09-1994	CN 1128590 A,B	07-08-1996
		EP 0720792 A	10-07-1996
		JP 9502065 T	25-02-1997
		WO 9506981 A	09-03-1995
EP 0735701 A	02-10-1996	US 5689439 A	18-11-1997
		CA 2172320 A	01-10-1996
		US 5657325 A	12-08-1997
US 5657325 A	12-08-1997	US 5689439 A	18-11-1997
		CA 2172320 A	01-10-1996
		EP 0735701 A	02-10-1996
		CA 2171998 A	04-10-1996
		EP 0736979 A	09-10-1996
		JP 8288934 A	01-11-1996